Meena Kotecha

Teaching mathematics and statistics: promoting students' engagement and interaction

Project Report

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Meena Kotecha
Departments of Mathematics/Statistics
The London School of Economics and Political Science
M.Kotecha1@lse.ac.uk [mailto:M.Kotecha1@lse.ac.uk]
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Introduction

This case study highlights the difference a teaching approach can make to students' engagement and motivation. Furthermore, it demonstrates the positive impact an effective approach can have on students' enthusiasm, their perceptions of mathematics and statistics, academic self-efficacy and their learning experience.

It will discuss strategies developed by the author to improve learning and teaching in statistics and mathematics first year undergraduate service courses for economics, finance, management sciences and accountancy degree programs.

The strategies have been tried and tested by the author in seminars and lectures, and positively contributed to promoting students' participation and interaction as expected.

The exciting outcome of the discussed approach not only fulfilled author's initial expectations but far surpassed them. It increased students' engagement and their enthusiasm which improved their performance in seminar activities and coursework. Furthermore, it improved students' perceptions and attitudes to mathematics and statistics as reflected in their feedback. Some of their comments are included to highlight this.

It is argued that such an approach could not only enhance students' perceptions of the subjects and their engagement in seminars/lectures but also promote independent learning, reasoning and several transferable skills associated with university education.

Background, Approach and Methodology

The approach used was student centred and hence the focus was on students' engagement in seminars.

The initial approach used in seminars was to hand out the marked weekly homework assignments and work through the questions which seemed logical and natural to follow.

Observations and concerns

It can be argued that all observations *and concerns discussed below are common to all mathematics and statistics service courses. Furthermore, they can be successfully addressed by effective use of seminar* time and careful planning/designing of seminar activities.

a. Students generally seemed unhappy with the pace of delivery in seminars which was mainly because of the diversity in their abilities as a result of the variety of their academic and cultural backgrounds. Furthermore, students' expectations of teachers and their individual learning styles/needs differed. De Vita and Case recommend that this diversity creates an opportunity *"to reflect on and rethink not only what we teach but also how we teach."*
b. Some students found it hard to cope with the material covered in lectures and needed additional guidance and support.
c. Students generally found the course irrelevant to their respective career paths.
d. Some students seemed to lack confidence due to low academic self-efficacy which acted as a barrier to learning.

"…students are likely to have trouble with statistics due to non-cognitive factors, such as negative attitudes or beliefs towards statistics. Such factors can impede learning of statistics…" (Gal and Ginsburg).

It was the Teaching Quality Assurance and Review Office (TQARO) Qualitative/Quantitative survey results that acted as a trigger for prompt action, as they confirmed author's perceptions.

The main aim was to devise a teaching approach to address these issues by drawing from students' feedback.

Main hypothesis

Improvement in the teaching and learning climate will enhance student engagement.

Additional points for consideration

A pragmatic approach was used to develop the teaching and learning strategies drawing from students' informal/formal feedback. Furthermore, students' responses to optional open

-ended questions helped gauge changes in their perceptions of mathematics/statistics. Students' informal, unprompted and spontaneous feedback played an important part in contributing to shaping and developing ideas.

The original hypothesis was expanded in accordance with the students' feedback and further points for consideration were incorporated as below:

a. It is proposed that a variety in teaching approaches, formative assessments and seminar activities may improve the teaching and learning environment, facilitate effective learning and enhance academic performance.
b. Group activities may improve the social climate of seminars, improve the student-teacher rapport and promote statistical/mathematical thinking/reasoning.
c. Carefully designed formative assessments followed by instant feedback may enhance students' academic self-efficacy and interest in the course.

Teaching approach

Multiple choice questions (MCQs), short questions and group activities are used to encourage students' participation. A variety of learning outcomes relating to all of the competences in Bloom's taxonomy (Bloom) can be assessed by an effective use of MCQs.

An important consideration whilst designing questions is the diversity of students' cultural and academic backgrounds. Culture provides learners with a means of thinking which is referred to as the tools of intellectual adaptation by Vygotskians. *"It is the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers"*(Vygotsky).

MCQs are used in this case as diagnostic as well as formative assessments to fulfil three main purposes;

a. highlight problem areas and individual learning needs
b. clarify key concepts and terminology in the course material
c. promote active learning

One or two MCQs/short questions focusing on key concepts of the material covered in the previous lectures are used as the seminars begin. This captures students' attention and puts them in a receptive frame of mind. The answers are displayed giving students a brief explanation after a few minutes. This helps them link new concepts with their existing knowledge and they generally seem to appreciate the benefit of using MCQs. *"One thing I like about the classes is that you expose us to more questions; even though at the time they can be annoying in the sense that they seem complicated, I think that they will act as triggers for memory in the long run"* (student).

It is observed that students' academic self-efficacy levels are enhanced when they get answers to the MCQs correct. Even if they get them wrong their understanding improves because of the explanation that follows immediately in the form of instant feedback. MCQs can achieve a lot if designed carefully, focusing on the leaning outcomes of the course. *"… I am now much more familiar with the combinations formula, and the Binomial*

distribution; Overall, I'm thoroughly enjoying myself and my understanding of stats is growing" (student).

MCQs/short questions are successfully used in lectures at the beginning, half-way through and at the end of lectures to introduce interaction, make the pace of delivery manageable and avoid information overload. The cognitive structure of the working memory is limited in its capacity and duration (Simon).

Verbal feedback on their homework is combined with a brief recap of related concepts and key points. Common misconceptions are pointed out making constructive comments to avoid their future recurrence and students are advised to annotate their scripts for their reference. Detailed solutions are emailed the evening before each class, to help them reflect on these and seek clarification on their queries in class. Students appreciate the interactive nature of such feedback and use the opportunity to improve their understanding. *"I enjoy the classes as they are good in terms of feedback on our assignments and they provide a more detailed explanation of the course material…"* (student).

Their perceptions of the course improve as they begin to view the subjects positively. *"I used to dislike Statistics. However I do really enjoy the course now…"* (student).

The above quotes show how students' self-efficacy contributes significantly to their attitudes towards the course and may significantly contribute to their academic progress. *"Efficacy beliefs influence how people feel, think, motivate themselves and behave"* (bandura).

A glossary of statistical/mathematical terminology is handed out as appropriate to help students;

a. relate the terms to the right meaning
b. contextualise the terms

Biggs explains that *"Elaborating the material, removing misconceptions, applying to specific examples, comparing different interpretations are left to the complement of the lecture, the tutorial."* Students definitely seem to view this positively. *"…your slide shows summarising in a few lines and in a simple way the main points of the previous lectures are extremely important in reminding us of the material and getting us in the mood of the lesson"* (student).

Students are asked to attempt new problem solving questions advising them to work in pairs/groups. This promotes a positive learning climate, increases student participation, encourages student-teacher dialogue and facilitates deeper learning.

Furthermore, it creates the opportunity for the teacher to see students individually and address their queries effectively. Group work helps them develop interpersonal skills, effective communication, team working, and the ability to effectively contribute to discussions. Solving complex problem questions in groups enhances their understanding of the theoretical concepts and promotes deep learning as they often require the students to convince their peers of a specific approach to problem solving. *"I now fully understand the Combinatorics and Binomial theorem"* (student).

Classes/lectures are ended with a short question on the material covered asking students to reflect on it. This continues the exchange of ideas amongst students beyond the classroom

maximising the benefits of their intellectually stimulated and receptive frames of mind. Good dialogue elicits those activities that shape, elaborate and deepen understanding (Biggs). Such interaction is very enriching for both home and overseas students because it helps develop a global perspective and global citizenship across the institution (Shiel, Jones, Brown and Lunn)

It is important to review and modify the teaching approach to match the changing global landscape of higher education.

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